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THREE NEW SPECIES OF CITROPSIS, ALSO NEW VARIETIES OF ATALANTIA AND FORTUNELLA (RUTACEAE–AURANTIOIDEAE)

WALTER T. SWINGLE

With four plates

THIS PAPER is the last of three[1] published in this journal, describing the more important new genera, new species and new varieties brought to light in writing a synopsis of the Orange subfamily as a chapter in the first volume of "The Citrus Industry."[2]

The genus *Citropsis* includes plants found only in tropical Africa, rather closely related to *Atalantia* and somewhat remotely related to *Citrus*. They were formerly assigned to the old and much misunderstood genus *Limonia*. Engler described four new species of *Limonia* from tropical Africa in January, 1895[3] and in November of the same year[4] he established a new section, Citropsis, of the genus *Limonia* for these species. Three species were described and beautifully illustrated in folio size lithographic plates by Prof. De Wildeman in 1904.[5] The genus

[1]The two preceding papers in this series are:

SWINGLE, WALTER T. Clymenia and Burkillanthus, new genera, also three new species of Pleiospermium (Rutaceae-Aurantioideae). (Jour. Arnold Arb. **20**: 250–263, pls. 1–3. April 1939.)

SWINGLE, WALTER T. Limnocitrus, a new genus, also new species of Wenzelia, Paramignya and Atalantia (Rutaceae-Aurantioideae). (Jour. Arnold Arb. **21**: 1–25, pls. 1–4. Jan. 1940.)

[2]To be published by the University of California Press, Berkeley, Calif.

[3]ENGLER, A. Diagnosen neuer Arten. (Notizbl. Bot. Gart. Mus. Berlin, **1**: 28–29. Jan. 1895.)

[4]ENGLER, A. Rutaceae. (Engler and Prantl, Nat. Pflanzenfam. III. **4**: 189–190, fig. 109 E–H. Nov. 1895.)

[5]DE WILDEMAN, EMILE. Etudes de systématique et de géographie botanique sur la Flore du Bas- et du Moyen-Congo. (Ann. Musée Congo, Bot. sér. 5, **1**: 159–161, pls. 40, 41, 43. 1904.) Plates of *Limonia Demeusei, L. Lacourtiana* and *L. Poggei* var. *latialata*.

Citropsis was established in 1914;[6] it was accepted and attentively studied by Engler in 1915[7] who added one new species, *C. Zenkeri*, and reduced one of his own to synonymy. In 1931[8] he noted briefly the "4 or 5" species then known and one or two doubtful synonyms. Finally, Prof. Pynaert, Director of the Colonial Botanic Garden in Belgian Congo, published in 1935[9] a popular account of the genus.

It now appears that there are three new species to be added to those already known, making a total of eleven species. As the number of species of *Citropsis* was increased by the repeated discovery of new ones, it became more and more difficult to distinguish them clearly from each other. Fortunately in 1914[10] valuable new characters were discovered in the size, proportion of parts, etc., of the pistil, which permitted a much clearer distinction of the species than had been possible hitherto.

Engler in the following year used to the full the pistil characters in describing and figuring *C. Zenkeri* and other species of the genus. Recently, by restoring herbarium material of flowers, fruits, etc. as nearly as possible to their natural fresh condition by the modified Juel technique[11] then imbedding them and cutting serial microtome sections, it has been possible to bring to light additional important anatomical and morphological characters shown by the disk, ovary, style and stigma, which still further facilitate the clear distinction of the species.

Citropsis Gilletiana Swingle et M. Kellerman, sp. nov.

PLATE 1, FIGS. 1–7, PLATE 2, FIGS. 1–5.

C. latialatae affinis sed differt (1) pistillo duplo longiore, (2) foliolis terminalibus 1/5–1/3 longioribus quam foliolis lateralibus adjacentibus, (3) disco cupulato, duplo altiore, (4) habitu arboreo 8–10 m. alto, nec fruticoso 3–4 m. alto. Ab *C. articulata* differt stylo dimidio breviore et duplo latiore.

Arbor 8–10 m. alta, ramulis junioribus glabris, 2.5–4 mm. diam., internodiis 2–6.5 cm. (vulgo 3.5–4.5 cm.), spinis gracilibus, acutis, 2–5 cm. longis, solitariis vel binis; foliis maximis, 3–5-foliolatis, 16–37.5 × 10–36

[6]SWINGLE, WALTER T. & MAUDE KELLERMAN. Citropsis, a new tropical African genus allied to Citrus. (Jour. Agric. Research, 1: 419–436, pl. 49, text figs. 1–7. Feb. 1914.)

[7]ENGLER, A. Die Pflanzenwelt Ostafrikas, 3: 758–760, fig. 354 A–N. 1915. (ENGLER & O. DRUDE. Vegetation der Erde, Vol. 9.)

[8]ENGLER, A. Rutaceae. (Engler & Prantl, Nat. Pflanzenfam. ed. 2, **19a**: 347–349, fig. 158 A–N. 1931.)

[9]PYNAERT, E. Les Aurantiées du genre Citropsis. (Bull. Agric. Congo Belge, **26**: 305–314, no. 3, 1935.)

[10]SWINGLE, WALTER T., & M. KELLERMAN, l.c.

[11]SWINGLE, WALTER T. New methods utilized in studying the taxonomy of the orange subfamily. (Jour. Wash. Acad. Sci. **29**: 270. 1939.)

cm., margine crenulatis vel denticulatis, aliquando irregulariter leviter lobulatis, foliolis terminalibus 9–21 × 5–13.5 cm., lateralibus (semper minoribus quam terminalibus) 7–17 × 4–9.5 cm., petiolis late alatis obovatis vel obcordatis, 6–10 × 3.5–7.5 cm., segmentis rhacheos (1 vel 2) ellipticis vel obovatis, 3.5–9.5 × 1.5–7.5 cm. (vulgo 3.5–6 × 1.5–4 cm.); inflorescentiis axillaribus, racemosis, brevibus, 5–12 mm. longis; pedicellis 3–5 mm. longis instructis; floribus albis, numerosis, 1.5–2.5 cm. diam., 4-meris; calycis lobis triangularibus, acutis, 2 × 2 mm.; petalis 4, 16–18 × 4.5–5.2 mm.; staminibus 8, filamentis glabris, applanatis, liberis; disco 0.8–0.9 alto × 2.2–2.4 mm. lato, cupulato (0.3 mm. alto); pistillo (cum disco) 10–13 mm. longo, ovario ovoideo, 2.5–3.5 × 2.5–3 mm., 4-loculari, loculis 1-ovulatis, stylo 4.5–6 × 1.2–1.3 mm., stigmate depresso-globoso, 1.2–1.3 mm. alto, 2.5 mm. lato; fructibus subglobosis, 24–25 mm. diam., pedicellis 7–9 mm. longis, maturitate colore fructibus *Citri limoniae* similibus, cortice tenui (1–2.2 mm.) loculo quoque vesiculis pulpiferis numerosissimis granulis cerae flavae repletis; seminibus albis, glabris, fere 2–3 (aliquando nullo), ovoideis, 9.5–10 × 5–6 mm.

Tree 8–10 m. tall, young branches glabrous, 2.5–4 mm. diam., internodes 2–6.5 cm. (usually 3.5–4.5 cm.) long, spines slender, acute, 2–5 cm. long, solitary or in pairs; leaves very large, 3–5-foliolate, 16–37.5 × 10–36 cm., terminal leaflets 9–21 × 5–13.5 cm. lateral ones (always smaller than the terminal) 7–17 × 4–9.5 cm., petioles obovate or obcordate, 6–10 × 3.5–7.5 cm., segments of rachis (1 or 2) elliptical or obovate, 3.5–9.5 × 1.5–7.5 cm. (usually 3.5–6 × 1.5–4); inflorescences racemose, axillary, short, 5–12 mm. long, pedicels 3–5 mm. long; flowers white, numerous, 1.5–2.5 cm. diam., 4-merous, calyx lobes triangular, acute, 2 × 2 mm., petals 4, 16–18 × 4.5–5.2 mm.; stamens 8, filaments glabrous, flattened, free, disk 0.8–0.9 mm. high, 2.2–2.4 mm. wide, cupulate (0.3 mm. deep), pistil (including disk) 10–13 mm. long, ovary ovoid or barrel-shaped, 2.5–3.5 × 2.5–3 mm., 4-locular, locules with 1 ovule, style 4.5–6 × 1.2–1.3 mm., stigma depressed-globose, 1.2–1.3 mm. high, 2.5 mm. wide; fruits subglobose, 24–25 mm. diam., with pedicels 7–9 mm. long, lemon-colored when ripe, peel thin (1–1.2 mm.), locules with very numerous pulp vesicles filled with granules of yellowish wax; seeds white, smooth, usually 2–3 (often none), ovoid, 9.5–10 × 5–6 mm.

TYPE: Washington, D. C., Bureau of Plant Industry Citrus Greenhouse, tree grown from seeds sent from Kisantu, Belgian Congo by Père J. Gillet. *Swingle CPB No. 7800* G, PEI No. 109622, Mar. 10, 1939, flowering branch (Herb. National Arboretum, sheet No. 71502).

COTYPE 1: From same collection, Fessenden natural color process,

preserved in soribitol derivatives, sealed in cellulose acetate (Herb. National Arboretum, sheet No. 71503).

COTYPE 2: From same tree, *Swingle*, coll. Aug. 1939, leafy branches and dried fruit (Herb. National Arboretum, sheet No. 71504).

COTYPE 3: Material from type tree. Serial microtome sections S. and T. No. 501 A, slides 1–17, and S. and T. No. 501 B, slides 1–14 (1156 cross sections of two flower buds); S. and T. No. 501 C, slides 1–5, No. 501 D, slides 1–4 (183 longitudinal sections of two flower buds) (Herb. National Arboretum).

TOPOTYPE 1: Belgian Congo, Kisantu, coll. *Père J. Gillet*, Mar. 21, 1913, C.P.B. No. 7711, with very young fruits (Herb. National Arboretum, sheet No. 71505).

OTHER MATERIAL: Jard. Bot. Brussels, *W. Robyns*, June 1938, from a tree grown from seeds collected by Père J. Gillet, Kisantu, Belgian Congo in 1906. (Herb. National Arboretum, sheet No. 71506, also photographs and serial microtome sections S. and T. No. 670.)

This giant species of *Citropsis*, the largest in the genus, which grows to a height of 8 or 10 meters, probably has also the largest leaves of any species although two other species have leaves almost as large. However, one of these species, *C. articulata*, has very different flower characters, the style being twice as long but only half as wide as that of *C. Gilletiana*; the other species, *C. latialata*, was found from a study of the type material to have pistils only about half as long as those of *C. Gilletiana* and also with much larger oil-glands in the swollen stigma.

The type tree of *C. Gilletiana* was grown from seed sent by Père J. Gillet from his Botanic Garden at Kisantu in the lower Congo valley in Belgian Congo in March 1913. Unlike *C. Schweinfurthii*, growing alongside in the greenhouse, the young tree did not flower for many years and then only sparingly. For the last few years it has flowered and fruited profusely. For many years it has grown vigorously and produced enormous leaves, both 3- and 5-foliolate. A 3-foliolate leaf at the base of a vigorous water-sprout was 28.5 cm. long and 31 cm. wide. The terminal leaflet measured 20.5 × 14 cm., the two lateral leaflets 16.5 × 9.5 cm. The largest leaflets had 7–10 principal lateral veins, raised on the under surface and sunken on the upper surface. The surface of the leaflet was usually more or less bullate because of the upward curving of areas of the leaf surface limited by the principal veins and their cross veinlets. The leaflet margins were crenulate or even subserrate, sometimes irregularly incised. The winged petiole, cordate in outline, measured 8.5 × 7.2 mm. A large 5-foliolate leaf higher up on the same shoot,

measured 37.5 cm. long and 36 cm. wide; the terminal leaflet (somewhat deformed) was 18 × 10 cm. The two highest lateral leaflets were 18.5–19 × 10.5–11 cm. One of the lower leaflets was 16 × 10.25 cm. (the other was imperfect). The elongate, elliptical, winged rachis segments measured 9.5 × 4.5 cm., the elliptical winged petiole about 10 cm. long and about 7.5 cm. wide (one side defective). These are the largest leaves and leaflets yet reported on a near-citrus or true citrus fruit tree, though they are greatly exceeded in size by the leaves of some species of *Clausena*.

Citropsis Gilletiana is an important disease-resistant rootstock on which the commonly cultivated species of *Citrus* grow well in Belgian Congo and remain free from injury by larvae of a beetle (*Monohammus* sp.) which attacks the bark of all species of *Citrus* (even the highly resistant sour orange) and makes them liable to gum disease (caused by a fungus, *Phytophthora* sp.).[12]

In the Colonial Botanic Garden at Eala on the Congo river it was found that *C. Gilletiana* makes an excellent rootstock for many of the cultivated varieties of *Citrus* (such as sweet orange, mandarin, grapefruit, and lemon); in fact they all grew better when grafted on *C. Gilletiana* than on sour orange.[13]

Citropsis Gilletiana was introduced into the National Botanic Garden at Brussels, Belgium, by seeds sent in 1906 by Père Gillet from Kisantu, Belgian Congo. Flowers from one of the plants at Brussels kindly sent to us by Director W. Robyns in 1938, and after being restored by the Juel method could not be distinguished from those from the type tree growing in the Citrus greenhouse at Washington.

There are also living plants of this species growing and fruiting freely in a greenhouse in the Colonial Garden at Laeken, Belgium. An excellent figure of this plant published by Goossens,[14] shows clearly terminal leaflets larger than the lateral ones as in typical *C. Gilletiana*.

As the above species, *C. Gilletiana*, has been, to date, inadequately distinguished from another large-leaved species, *C. latialata*, also native in the Congo basin, it is desirable to supplement De Wildeman's excellent description of the leaf characters and his beautiful lithographic plate of this latter species with a description of the flower parts.

[12]Staner, P. Maladies du Citrus au Congo Belge. (Bull. Agric. Congo Belge, **20**: 364–373, figs. 170–176. 1929.)

[13]Pynaert, l.c., 314.

[14]Goossens, Victor. Note sur le Limonia Poggei Engl. var. latialata De Wild. employé pour la greffe de l'oranger au Jardin Botanique d'Eala. (Bull. Agric. Congo Belge, **15**: 157–162, figs. 42–45. 1924.)

Citropsis latialata (De Wild.) Swingle & M. Kellerman in Jour. Wash. Acad. Sci. **28:** 533. 1938. PLATE 2, FIGS. 6–10.

Limonia Poggei var. *latialata* De Wildeman in Ann. Mus. Congo. Bot. 5 sér. **1:** 160. pl. 43. 1904.

TYPE: Belgian Congo, Sankaru-Kasai, Ikongu. *L. Gentil No. 1,* flowering branch (Herb. Jard. Bot. de l'État, Brussels; photographs, serial microtome sections S. and T. 397 A, slides 1–6 [429 cross sections of half of one flower], No. 397 B, slides 1–2 [26 longitudinal sections cut to the median line of the same flower] in Herb. National Arboretum).

In the original description of his variety, *latialata,* De Wildeman says, in translation: "Shrub 3–4 m. tall; . . . leaves odd-pinnate with two pairs of lateral leaflets . . . petiole 3–8.5 cm. long and 1.5–5 cm. wide, . . . rachis [winged], reaching 4.5 cm. diam., leaflets oblong, narrowed into a very short petiolule; cuneiform at apex and at base; . . . 6–15 cm. long and 2–7 cm. wide, margins irregularly denticulate, terminal leaflet regular, cuneiform at base, of the same size as the lateral [leaflets] . . . flowers white with the odor of orange [flowers]; inflorescences axillary or terminal, ovary ovoid, terminated by a style twice as long, surmounted by a trilobed stigma."

A note states that the material brought by L. Gentil was in flower when collected but "the petals fell off during the preparation," fruits were not seen.

A single flower from the type specimen was kindly supplied for study by Prof. W. Robyns, Directeur du Jardin botanique de l'État at Brussels and was restored by the modified Juel method, imbedded in paraffin and cut into serial microtome sections. First the pistil was cut into 26 longitudinal sections until a section was obtained exactly through the center; then the paraffin block was turned at right angles and 429 cross sections, 20 μ thick, were cut, including the entire length of the pistil, disk, calyx and pedicel.

The calyx is 4-merous, the lobes about 1.2 mm. wide and 1.5 mm. long, thick in the middle but with thin edges; disk shallow, cup-shaped, 0.3–0.4 mm. tall and 1.1–1.2 mm. wide, pistil 6.4 mm. tall, including the shallow disk, ovary ovate, 1.8 mm. tall and 1.6 mm. wide, merging rather abruptly into the style which is 0.8 mm. diam. at junction with the ovary and nearly 1 mm. where it joins the stigma; stigma cushion-shaped, 1.5 mm. wide and 0.5–0.6 mm. high, more or less 4-lobed, with 4 medium-sized oil-glands.

This species differs greatly from *C. Gilletiana* with which it has been confused. *Citropsis latialata* is a small shrub instead of a large tree (up to 10 m. high) and has somewhat narrower leaflets and the terminal

leaflet is of about the same size or only very slightly larger than the adjacent lateral leaflets. The pistils are only a trifle more than half as long as those of *C. Gilletiana*, and show a shorter, less deeply cupped nectary and a more flattened stigma with 4 medium-sized oil-glands, distinctly larger and fewer than those occurring in the stigma of *C. Gilletiana*.

Citropsis Tanakae, Swingle et M. Kellerman, sp. nov.

PLATE 3, FIGS. 1–5.

Frutex vel arbor, ramulis gracilibus, 1.5–3 mm. diam., spinis solitariis, axillaribus, gracilibus brevibusque (5–10 mm.); internodiis 1.5–2.5 cm.; foliis simplicibus, rotundato-lanceolatis, 8–10 × 6–3 cm., apicem versus sensim in acumen crassum obtusum attenuatis, basi late cuneatis, nervis lateralibus numerosis, utrinque 10–12, sub angulo 75°–80° divergentibus, margine apicem versus regulariter sed tenuiter crenulatis, ad basin subintegris, in petiolum decurrentibus; petiolis brevissimis (3.5–4 mm.), apteris, gracilibus (1–1.5 mm. latis), glabris, cum lamina foliorum non articulatis; inflorescentiis brevissimis, paucifloris, axillaribus; alabastris parvis (immaturis?) circa 8 × 3 mm., pedicellis brevibus 2–3 mm. (vel plus?) longis et 0.5–0.75 mm. diam. instructis, calyce glandulis oleiferis asperato, glabro, lobis 4, 0.3–0.4 mm. longis, subacutis, marginibus tenuibus scariosisque, glandula oleifera singula magna ad apicem instructis, petalis 4, circa 7 × 3 mm. in alabastro, glabris, glandulis multis oleiferis instructis, ad apicem numerosioribus, staminibus 8, circa 6 mm. longis, filamentis glabris, circa 5 mm. longis, applanatis, 2 vel 3 in fasciculis cohaerentibus, antheris circa 3 mm. longis, ad apicem connectivi glandula oleifera instructis, disco cylindrico, glabro, cupulato, 0.10–0.15 mm. alto, pistillo 5.6 mm. longo, ovario 4-loculari, ovoideo, 0.8 × 0.93 mm., apice rotundato, glandulis oleiferis magnis super quemque loculum destitutis; stylo longo, gracili (4.6 × 0.3–0.4 mm.), stigmate depresso-globoso, 0.7 mm. alto, 0.9 mm. lato, 5–7 glandulis oleiferis magnis instructo.

Branches slender, 1.5–3 mm. diam., with solitary, axillary, slender, short spines; internodes 1.5–2.5 cm. long; leaves simple, broadly lanceolate, tapering gradually (or slightly acuminate) into a short, thick, blunt acumen, 8–10 × 6–3 cm., base broadly cuneate with the margins slightly decurrent into upper part of petiole, lateral veins numerous, 10–12 on each side, arising at angles of about 75°–80° with the midrib, margins regularly but shallowly crenulate on upper half, subentire below; petioles very short (3.5–4 mm. long), wingless, slender (1–1.5 mm. wide), glabrous, not articulated with the leaf-blade; inflorescences very short, few-flowered, axillary; flower buds (immature?) small, about 8 × 3 mm., borne on short slender pedicels, 2–3 mm. (or more?) long, 0.5–

0.75 mm. diam.; calyx roughened with numerous oil-glands, glabrous, calyx lobes 4, short (0.3–0.4 mm.), with thin scarious edges, with a single rather large oil-gland near the subacute tip (Plate 3, figure 2), petals 4, about 7 × 3 mm. (in the immature bud), glabrous, with many medium-sized oil-glands, more abundant at the pointed tips, stamens 8, about 5.5–6 mm. long, filaments glabrous, somewhat flattened, broad at the base where they cohere in groups of 2 or 3 for some distance (about 2.8 mm.), anthers about 3 mm. long, with a single small oil-gland near the top of the connective, disk cylindrical, glabrous, shallow, cup-shaped, fitting rather closely over the base of the ovary for about 0.1 mm. with a few small oil-glands on the margin of the cup, pistil 5.6 mm. long, ovary 4-loculed, ovoid, 0.93 mm. long, 0.8 mm. wide, rounded at top without a large oil-gland over each locule, style long and slender (4.6 mm. long, 0.3–0.4 wide), slightly contracted where it joins the ovary in which it is very slightly countersunk, slightly expanded at the apex where it merges into a depressed globose stigma, 0.7 mm. high and 0.9 wide, containing several (5–7) large oil-glands.

TYPE: Sierra Leone, *Afzelius*, a twig with a single flower bud (Herb. Univ. Uppsala; one leaf with petiole; photographs and serial microtome sections S. and T. No. 226 A, slides 1–6, [454 transverse sections of 1 flower bud] in Herb. National Arboretum.)

This species is known only from a single twig, about 20 cm. long, with 7 leaves and a single flower bud, collected in Sierra Leone between 1794 and 1796 by the Swedish botanist Afzelius who identified it as *Citrus Medica*, doubtless because the petioles were not articulated with the leaf-blade. Prof. T. Tanaka, about ten years ago, saw Afzelius' specimen in the herbarium of the University of Uppsala, in Sweden, and perceived at once that it did not belong to the genus *Citrus*, but was instead a species of *Citropsis*. He never published this species, but did figure it.[15] It is, therefore, appropriately named in his honor. Thanks to the kindness of the Curator of the Herbarium at the University of Uppsala, a single leaf and the unique flower bud were sent to us for study. By restoring the bud and cutting it into serial microtome sections by the Juel method discovered at the University of Uppsala, it has been possible to prove beyond doubt that Afzelius' plant is a new species of *Citropsis* very different from any of the other ten species now known. This very old material could not be restored as well as usual. Nevertheless, it was possible to work out the flower structure in minute detail.

This remarkable species is unique in the genus because of its simple

[15]TANAKA, TYOZABURO. Kenkitsu no kenkyu, Citrus Studies, p. 78, fig. 71, left, 1933, a very small figure labeled "*Citropsis citrifolia*," nomen nudum.

leaves with very short wingless petioles (only 1/20 as long as the leaf-blade and not articulated with it). All other species of *Citropsis* have odd-pinnate leaves, 3–7-foliolate or occasionally (in *C. gabunensis*) 1-foliolate leaves with petioles that are, however, never less than 1/8 as long as the leaf-blade. *Citropsis Tanakae* has flowers somewhat resembling the subgenus Afrocitrus (see page 126) in having a subglobose stigma distended with large oil-glands, borne on a slender style, but lacks the large oil-glands, one at the top of each locule, which characterize the species of this subgenus. Not until fully developed flowers and mature fruits are available for study will it be possible to determine the exact relationships of *C. Tanakae*.

Besides being one of the most distinct species of the genus, it is also the northernmost species in Africa, occurring in Sierra Leone, some 500–600 kilometers northwest of *C. mirabilis* (in the Ivory Coast in West Africa) from which it differs in almost all of its characters.

Citropsis Daweana Swingle et M. Kellerman, sp. nov.

PLATE 3, FIG. 6.

Frutex vel arbor parva, 3–5 m. alta, ramulis primo angularibus, demum cylindricis, 2–4 mm. diam.; internodiis 2–3 cm. longis; spinis axillaribus, solitariis, brevibus, rectis, 1–2.5 cm. longis, ad basim 2–4 mm. diam., brevioribus obtuse, longioribus (1.5–2.5 cm.) acute acuminatis; foliis 5–7-foliolatis, foliolis ellipticis vel rhomboideis, apice truncato-rotundatis, terminalibus basi anguste cuneato 5–5.8 × 2–2.4 cm., lateralibus basi late cuneatis vel rotundatis, 2–4.5 × 1.5–2.4 cm., margine tenuiter crenulatis vel subintegris, utrinque leviter pubescentibus, praecipue secus nervos et ad marginem; petiolis fere apteris vel apteris, 1.2–2.2 × 0.15 cm., pubescentibus, segmento racheos inferiore 2–2.5 cm. longo, spatulatis, basi anguste, apicem versus late (3–6 mm.) alatis, apice rotundato, segmento superiore racheos elliptico, 5–8 mm. lato, nec spatulato; flores fructusque ignotae.

A shrub or small tree, 3–5 m. high, branchlets at first angular, soon cylindrical, 2–4 mm. diam.; internodes 2–3 cm. long; spines axillary, solitary, short, straight, 1–2.5 cm. long, 2–4 mm. diam. at base, shorter ones blunt-pointed, the longer ones (1.5–2.5 cm.), sharp-pointed; leaves 5–7-foliolate, leaflets elliptical to rhomboid, bluntly rounded at the tip, terminal one narrowly cuneate at base, 5–5.8 × 2–2.4 cm., lateral ones broadly cuneate or broadly rounded at base, 2–4.5 × 1.5–2.4 cm. margins finely crenulate or subentire, sparingly pubescent on both sides especially along the veins and at the margins; petioles nearly or quite wingless, 1.2–2.2 cm. long, 1.5 mm. wide, pubescent, basal segments of

rachis 2–2.5 cm. long, spatulate, narrowly winged at base and broadly winged (3–6 mm.) at apex, which is rounded, second rachis segment elliptical, 5–8 mm. wide, not spatulate; flowers and fruits unknown.

TYPE: Madanda Forest, Portuguese East Africa (Mozambique). *Dawe No. 443* (Type, Herb. Brit. Mus.: fragment in Herb. National Arboretum. PARATYPE, Herb. Kew; photograph in Herb. National Arboretum).

Unfortunately no flowers or fruits of this species are available for study. The leaves cannot be mistaken for those of any other species as they have a wingless petiole (although the rachis segments are clearly winged) and have leaflets more or less pubescent on both surfaces.

This species has the appearance of being more or less xerophytic, while the other species are evidently mesophytes growing, or at least, starting as seedlings, in the shade of larger trees in the tropical rain forests. The type material seems to show *kurztriebe* like the leaf and fruit spurs of *Poncirus* and some of the hard-shelled citrus fruit trees (subtribe Balsamocitrinae).

The leaf, petiole and rachis characters of this species show a great similarity to those of certain forms of *Hesperethusa crenulata* (Roxb.) Roem. from peninsular British India. However, certain forms of *Citropsis gabunensis* (Engl.) Swing. & M. Kell. have leaves and petioles greatly resembling those of *Citrus* but have flowers and fruits unmistakably belonging to *Citropsis*. Only the study of flowers and fruits can reveal the exact relationships of *Citropsis Daweana*.

Citropsis gabunensis var. **Lacourtiana** (De Wild.) Swingle et M. Kellerman, comb. nov.

Limonia Lacourtiana De Wildeman in Ann. Mus. Congo Bot. 5 sér. **1**: 159, pl. 50. 1904.

Differt a typo fructu cortice molli, pulpa tenera succosa suavissima, seminibus parvis (saepe nullo).

Fruits subglobose, 1.8–2 cm. diam., yellow-orange when ripe, peel 2–2.5 mm. thick, rather soft, pulp tender, juicy and of very agreeable flavor, seeds few or none, plump, subglobose, bluntly conical at one end, 11 × 8.5–9 mm.

TYPE: Bombaye, Sankuru (Lualaba-Kasai), Belgian Congo, *L. Gentil No. 93*, fruiting branch (Herb. Jard. Bot. de l'État, Brussels; part of type collection [leafy branch and fruit], photographs and serial microtome sections S. and T. No. 532 A, slides 1–5 [14 transverse sections of a fruit from type specimen] in Herb. National Arboretum).

The type specimen of *Limonia Lacourtiana* was kindly loaned to us by

Dr. W. Robyns, Director of the Jardin Botanique de l'État at Brussels. It consisted of a single fruiting branch collected in May 1902 with a number of half-grown and three nearly mature fruits, most of them seedless but one (or two?) having a single, yellowish brown, rather large, plump, short-ovoid seed, 11 × 8.5–9 mm., with a very hard smooth testa, having a smooth-edged hilum 2 × 1 mm. Gentil's original field label attached to the type sheet calls the plant "un mandarinier sauvage" and notes its "fruit délicieux." The fruits occur in dense axillary clusters and are borne on pedicels 8–13 mm. long which in turn are densely crowded on a very short peduncle only 4–10 mm. long.

Two species of *Citropsis* which have fruited in the United States, *C. Schweinfurthii* and *C. Gilletiana*, both produce an abundance of small orange-like fruits but they are not edible as the pulp vesicles contain numerous granules of a waxy substance of disagreeable flavor.

Doubtless *C. gabunensis*, belonging, as it does, to a very different group (the type of a new subgenus discussed below), does not produce this ill-flavored wax. The species itself has fruits so full of plump seeds as to leave very little space for pulp. The variety *Lacourtiana* on the contrary usually has seedless fruits that are filled with high-flavored pulp.

TWO SUBGENERA IN CITROPSIS

In making a detailed study of all the species of the genus *Citropsis*, it soon became evident that the nine species of which flowers and fruits are known fall naturally into two groups clearly distinguished by characters having taxonomic importance in this genus.

I. EUCITROPSIS Swing. et M. Kell., subgen. nov., foliolis magnis rhachibus late alatis, pistillo crassiusculo, ovario ovoideo sine glandulis oleiferis ad apicem cujusque loculi, stigmate depresso-globoso sine glandulis oleiferis magnis.

1. *Citropsis Schweinfurthii* (Engl.) Swing. & M. Kell. (Type species)
   Uganda, East African plateau.
2. *C. angolensis* Exell.
   Angola, Southwest Africa.
3. *C. articulata* (Willd.) Swing. & M. Kell.
   Gold Coast, West Africa.
4. *C. mirabilis* (A. Chev.) Swing. & M. Kell.
   Ivory Coast, West Africa.
5. *C. Gilletiana* Swing. & M. Kell.
   Congo River Valley, Central Africa.
6. *C. latialata* (De Wild.) Swing. & M. Kell.
   Congo River Valley, Central Africa.

These species close to the type of the genus have large flowers much like those of *Citrus*, with rather thick pistils (particularly a thick style); the ovary locules do not show a large oil-gland at the tip of each locule and the stigma shows only small or medium-sized oil-glands; the leaves are large, acute at the tip, but not acuminate or caudate; the petioles and rachis segments are very broadly winged.

II. AFROCITRUS Swing. et M. Kell., subgen. nov., foliolis parvis, rhachibus anguste alatis vel apteris, pistillo parvo, ovario obclavato vel oboideo, cum glandulis oleiferis magnis ad apicem cujusque loculi, stigmate subgloboso glandulis oleiferis magnis instructis.

7. *C. gabunensis* (Engl.) Swing. & M. Kell. (Type of subgenus)
Gabon, West Africa.

7a. *C. gabunensis* var. *Lacourtiana* (De Wild.) Swing. & M. Kell.
Sankuru River Valley, Belgian Congo.

8. *C. Le-Testui* Pellegrin
French Congo, Congo River (lower valley).

9. *C. Zenkeri* Engler
Cameroons, West Africa.

The three species that constitute this subgenus all have small leaflets with acuminate or caudate tips and all, except *C. Le-Testui*, have petioles and rachis segments narrowly winged; the flowers are small or very small and the pistils (especially the style) extremely slender; the tip of the ovary is swollen by 4 large oil-glands, one at the tip of each locule; the stigma is unusually large (more than twice as broad as the tip of the style) and distended by very large oil-glands.

III. INADEQUATELY KNOWN SPECIES OF UNCERTAIN RELATIONSHIPS.

10. *C. Tanakae* Swing. & M. Kell.
Sierra Leone, West Africa.

11. *C. Dawcana* Swing. & M. Kell.
Mozambique, Southeast Africa.

The mature flowers and fruits of *C. Tanakae* and the flower buds, flowers and fruits of *C. Daweana* are unknown. Both of these species have many characters that distinguish them sharply from all the other species of *Citropsis*, and they do not now appear to belong to either one of the two subgenera described above.

In addition to the 11 species mentioned above, there are one or two other plants such as *Limonia Demeusei* De Wild. and *L. Poggei*, of which the flowers are still unknown; these may possibly prove to be be distinct species of *Citropsis* when adequate material is available for study.

THREE NEW VARIETIES IN THE GENUS ATALANTIA

Atalantia racemosa var. **Henryi** var. nov. PLATE 4, FIGS. 1–4.

Differt a typo (1) foliis majoribus, (2) basi fere cuneatis nec rotundatis, (3) pedicellis florum longioribus, (4) ovariis 4-locularibus nec 2- vel 3-locularibus.

A small tree 4–7 m. high, ultimate branches slender, 2–3 mm. diameter, soon terete, spineless; leaves glabrous, lanceolate, 9–13 cm. long and 3.5–5.4 cm. wide, short-acuminate at apex, acumen 5–8 × 4–3 mm., tip blunt or even slightly emarginate, cuneate at base, lateral veins very numerous, 15–30 on each side not all clearly marked, arising at angles of 50°–70° with the midrib, margins subentire, petioles 5–10 × 1.2–2 mm., glabrous, coriaceous, more or less wrinkled, with a deep narrow channel 0.5–0.8 mm. wide on upper side, articulated with the leaf-blade; inflorescences single axillary racemes, 1–2.5 cm. long, with 5–15 flowers borne on slender pedicels 3–5 mm. long, peduncles, pedicels and calyx pubescent, flower buds subglobose, 3–4 mm. diam., calyx lobes rounded, 1.8–2 mm. long, 2–3 mm. wide, margins thin and ciliate, petals oblong, rounded at apex, stamens 8, filaments glabrous or very sparingly short ciliate, more or less cohering irregularly in groups, sometimes almost to the tips, in other flowers free almost to base, anthers about 2 mm. long, attached near the middle to the narrowed filament, connective bearing 1 medium-sized oil-gland near tip; disk cup-shaped, 0.5 mm. high, 1.5 mm. wide, pistil 3.5–4 mm. long, ovary ovate 1.5 × 1.5 mm., 4-locular with two ovules in each locule, with one medium-sized oil-gland at top of each locule, style short and thick, 2 mm. long (including stigma), 0.7–0.9 mm. wide, stigma not clearly distinguished from the style, about 0.9–1 mm. wide, with 4 stylar canals with 2 medium-sized oil-glands in the space between each two stylar canals (Plate 4, figure 3), fruits subglobose, 1.5–2 mm. diam., borne sparingly (1–2?) on each raceme on pubescent pedicels 3–5 × 1.5–2 mm., with numerous sessile pulp-vesicles (scanty in ripe fruit from seed pressure ?), seeds 1–3, ovoid-oblong, 12 × 6–8 mm., monoembryonic.

TYPE: Southern Yunnan, Szemao, alt. 1220 m., *A. Henry No. 12930*, 2 flowering branches (Herb. Arnold Arboretum; photographs, fragments and serial microtome sections S. and T. No. 660 A, slides 1–5, and 660 B, slides 1–5 [464 cross sections of 2 flower buds], No. 660 C, slides 1, 2 and 660 D, slides 1, 2 [156 longitudinal sections of 2 flower buds] in Herb. National Arboretum).

COTYPE: Same locality, same collection, *A. Henry No. 12930*, flow-

ering branch (U. S. National Herbarium, sheet No. 459370; photographs and serial microtome sections S. and T. No. 176 A, slides 1–5, and 176 B, slides 1–5 [559 cross sections of 2 flower buds], No. 176 C, slides 1–3, and 176 D, slides 1–3 [138 longitudinal sections of 2 flower buds] in Herb. National Arboretum).

OTHER MATERIAL: China, Southern Yunnan, Chi-li District, Youlouh shan, alt. 1100 m., *C. W. Wang No. 78101;* Chi-li Distr. Man-ya, alt. 1800 m., *Wang No. 78013;* Chi-li Distr., Man-ya, alt. 1200 m., *Wang No. 29051;* Chi-li Distr., Kuen-ger, alt. 1100 m., *Wang No. 79434;* all 4 numbers fruiting branches (Herb. Arnold Arboretum; photographs, fragments and serial microtome sections of fruits of No. 78013, S. and T. No. 650 A, slides 1–4 [13 cross sections of 1 fruit] in Herb. National Arboretum).

This variety is based on a flowering specimen from Szemao, Yunnan, (lat. 22° 45′ long. 101° 5′) at an altitude of about 1220 m. and fruiting specimens from Chi-li District about 100 kilometers to the south-southwest at altitudes from 1100 to 1800 meters. It resembles the typical *A. racemosa* of western peninsular India in many ways, but has larger leaves, flowers with decidedly longer pedicels, and the ovary is 4-locular, not 2- or 3-locular as usually given for the species. The subglobose stigma of the variety shows on cross section 4 stylar canals and between each 2 stylar canals 2 small oil-glands (Plate 4, figure 4). Flowers of material of the species from Bombay and also from "Malabar, Concan, etc., coll. Stocks, Lau etc." (both from the Gray Herbarium) show the stigma scarcely larger than the style with two stylar canals (corresponding to the 2 locules of the ovary) and with no oil-glands between the stylar canals (Plate 4, figure 5). These may be male flowers with a defective pistil such as are common in the lemon and some other species of *Citrus*. However, the original description of *Atalantia racemosa* Wight[16] and the excellent plate accompanying it, describe and illustrate a 3- or 4-lobed capitate stigma that very probably had oil-glands within to cause it to expand to slightly more than twice the diameter of the style.

Other figures show the ovary to have 3 or 4 locules as described. Most botanists of British India have described the species as having the ovary with 2 or 3 locules.

For the present the south Chinese plant can probably best be classed as a variety of *A. racemosa*.

[16]In Hooker's Jour. Bot. 1: 64, pl. 122. January 1834. The name *A. racemosa* is often erroneously cited as having been published by Wight and Arnott in Prodromus Ind. Or. 1: 91, but this work had not been published as late as March 22, 1834, and probably did not appear until April 1834.

Atalantia Roxburghiana var. **Kerrii**, var. nov.

A typo differt (1) foliis coriaceis, (2) brevioribus latioribusque, (3) apice obtusioribus, (4) inflorescentiis multo longioribus.

A small tree up to 5 m. tall, ultimate branches at first green and slightly angular, soon brownish, terete and faintly striate longitudinally; internodes 1.2 cm. long; leaves thick and leathery, broadly oval or elliptical, smaller ones lanceolate, 9–15 cm. long (including the petiole), 3–8 cm. wide (usually 6–8 cm. wide) tapering to a blunt apex, broadly cuneate at base with numerous small oil-glands scattered over the whole surface of the leaf-blade but fewer near the margins which are entire or faintly crenulate and slightly thickened at the very edge, lateral veins 7–12 pairs, nearly straight or slightly curved, forking at 5/6 to 6/7 of the distance to the margin, making angles of 50°–60° (rarely 65°–70°) with the midrib, with numerous small lateral veinlets that anastomose; petioles stiff, glabrous, wrinkled, with a shallow channel on the upper side, 1–2 mm. wide, 0.4–0.5 mm. deep; inflorescences axillary, paniculate (?), 2–10 cm. long, peduncle 1–2 mm. diam., pedicels 5–11 × 1.25–1.8 mm.; fruits subglobose, 1.5–1.8 cm. diam., peel covered with large, slightly sunken oil-glands 0.5–0.9 mm. diam., 3-locular, pulp-vesicles numerous, sessile, 3–5 mm. long, filling all the space not occupied by the seeds, seeds ovoid, 11.5–12 × 10–11 × 6–8 mm., with a very thin papery testa (which swells and separates from the embryo in hot water), monoembryonic.

TYPE: Thailand (Siam), Sam Roi Jawt, alt. 300–500 m., *A. F. G. Kerr No. 10943*, July 12, 1926, fruiting branches (Herb. Univ. Aberdeen; photographs, fragments and serial microtome sections of a fruit, S. and T. No. 684 A, slides 1–4 [12 cross sections] in Herb. National Arboretum.)

This remarkable *Atalantia* has very large, very broad, coriaceous leaves; unfortunately it is known only in the fruiting stage, but because of its leaf-characters it differs strikingly not only from *A. Roxburghiana* but also from the other species known from the Indo-Chinese region. As the species of *Atalantia* are, most of them, very variable in many of their characters, it seems best to consider this striking form as a variety of *A. Roxburghiana* Hook. f., not uncommon in the Malay peninsula and reported from French Indo-China.

I take pleasure in naming this variety in honor of Dr. A. F. G. Kerr who has done so much to make known the rich flora of Thailand.

Atalantia Roxburghiana var. **kwangtungensis** (Merr.), comb. nov.

A. kwangtungensis Merr. in Philip. Jour. Sci. **21**: 496. 1922.

This variety differs from the species in having usually 5-merous flowers (instead of 4-merous) and staminal filaments cohering from the base for about half their length instead of being free.

Both this variety and var. *Kerrii*, as well as the species *A. Roxburghiana*, are said to be spineless. Tanaka (Jour. Bot. **68**: 62. 1930) referred *A. kwangtungensis* to *A. Roxburghiana* and Merrill (Lingnan Sci. Jour. **7**: 311. 1931) accepts this reduction. However, in view of the presence of characters in *A. kwangtungensis* not yet found in typical *A. Roxburghiana* it appears possible, even probable, that the South China form deserves to be recognized as a variety, as done here, pending further study of the *A. Roxburghiana* complex of forms.

A NEW VARIETY OF FORTUNELLA

Fortunella Hindsii var. **Chintou,** var. nov. PLATE 4, FIG. 6

A typo differt (1) foliis majoribus, tenuioribus, (2) spinis brevioribus gracilioribusque, (3) fructibus majoribus, 12–15 mm. diam., (4) chromosomatibus diploideis (gametis n = 9 et cellulis, 2n = 18) nec tetraploideis, (5) floribus minoribus cum petalis et lobis calycis brevioribus et disco breviore.

This variety differs from the parent species in its larger, thinner and somewhat narrower leaves, 3.5–8 × 1.5–2.5 cm., shorter and more slender spines and larger, slightly depressed globose fruits, 12–15 mm. in diam. (Plate 4, figures 6 and 7). It has the normal diploid number of chromosomes (9 in the gametes and 18 in the somatic cells) instead of twice as many (18 and 36) as in the parent species. It has also distinctly smaller flowers with petals 5–6 × 2.5–4 mm. instead of 6–7 × 4–5 mm. as in the tetraploid species, blunter and much shorter calyx lobes, 0.5–0.6 mm. long instead of 0.8–1.2 mm. as in the species; the disk is also somewhat narrower and evidently shorter.

TYPE: Cut from a plant brought from Japan in 1927 by W. T. Swingle C.P.B. No. 909, now growing at the Bell Plant Introduction Garden near Glenn Dale, Md., under P.E.I. No. 71293 *Swingle*, fruiting branch (Herb. National Arboretum sheet No. 71507).

This striking dwarf, small-fruited kumquat is the *chin tou* or golden bean of the Chinese, well known and commonly cultivated for centuries in China and Japan but unknown in other countries. It is highly probable that it is the diploid state of *Fortunella Hindsii* which grows wild in the mountains of southeastern China but is apparently not known in culture. This wild form is an autotetraploid state, the only one known in a wild condition.

Dr. A. F. Longley kindly examined the pollen mother cells of this variety and discovered they had only nine chromosomes in the nuclei of the gametic cells (18 in the nuclei of the somatic cells), as in all the wild species of *Citrus Fortunella* and other genera of the Orange subfamily that have been studied. He had previously studied the species itself, the wild *Fortunella Hindsii*,[17] and found the gametic nuclei contained eighteen chromosomes and the somatic cells were tetraploid, containing 36 chromosomes. This is the only known tetraploid wild plant of the Orange subfamily, although tetraploid mutations of several species of *Citrus* have arisen under culture. None of them is cultivated, being dwarfish with small fruits. We have here the unique case of a diploid mutation suitable for culture arising from a tetraploid wild form.

EXPLANATION OF PLATES

PLATE 1

Citropsis Gilletiana Swingle et M. Kellerman. All figures of material collected from the type tree. Figure 1, part of type herbarium specimen.

Figure 1. Flowering twig. ½ nat. size.

Figure 2. Flowers and very young flower buds above. Nat. size.

Figure 3. Pedicel, calyx, disk and pistil. × 3.7.

Figure 4. Longitudinal section of nearly mature flower bud. × 4.5.

Figure 5. Cross sections of flower bud showing cup-shaped disk between stamens and ovary base, also corolla and tips of calyx lobes. × 4.5.

Figure 6. Cross section of ripe fruit with seeds. Nat. size.

Figure 7. Ripe fruit attached to twig. Nat. size.

PLATE 2

Citropsis Gilletiana Swingle et M. Kellerman. Figures 1–4 from type material. Figure 5, plant in Jardin botanique d'Eala, Belgian Congo.

Figure 1. Three stamens. × 3.7.

Figure 2. Serial cross sections of ovary, staminal filaments and part of corolla. × 4.2.

Figure 3. Serial cross sections of stigma below apex, surrounded by petals. × 4.2.

Figure 4. Serial cross sections of stigma near apex, showing stylar canals and 2 small oil-glands between. × 4.2.

Figure 5. Live fruiting branch of tree. (Copied from Goossens.) ⅛ nat. size.

[17] LONGLEY, ALBERT F. Polycarpy, polyspory and polyploidy in Citrus and Citrus Relatives. (Jour. Wash. Acad. Sci. **15**: 347–351, 1 fig. 1925.)

Citropsis latialata (De Wild.) Swingle et M. Kellerman. Figures 6–10 from type specimen.

Figure 6. Very large leaf. ¼ nat. size.

Figure 7. Longitudinal serial sections of pistil. × 4.2.

Figure 8. Longitudinal sections of pedicel, calyx and disk detached from same pistil. × 4.2.

Figure 9. Serial cross sections of ovary (from same pistil as figures 7 and 8). × 4.2.

Figure 10. Serial cross sections of stigma showing stylar canals alternating with a single large oil-gland. × 4.2.

PLATE 3

Citropsis Tanakae Swingle et M. Kellerman. Figures 1–5 from type specimen.

Figure 1. Leafy twig with the flower bud later cut into serial microtome sections. (Photograph by Tanaka.) ½ nat. size.

Figure 2. Serial cross sections of flower bud showing origin of stamens, corolla and calyx lobe tips each with a single large oil-gland. × 10.5.

Figure 3. Cross sections of flower bud showing nectary partly enclosing base of ovary, also cohering staminal filaments and corolla. × 10.5.

Figure 4. Cross sections showing 4-locular ovary and stamens cohering in several groups. × 10.5.

Figure 5. Cross sections of flower bud showing stigma with large oil-glands surrounded by anthers, one (above) showing a single large oil-gland in the tip of the connective, the whole enclosed by petals showing many oil-glands. × 10.5.

Citropsis Dawcana Swingle et M. Kellerman. Cotype.

Figure 6. Twig with spines and one 7-foliolate leaf, also several wingless petioles supporting a winged rachis segment. ½ nat. size.

PLATE 4

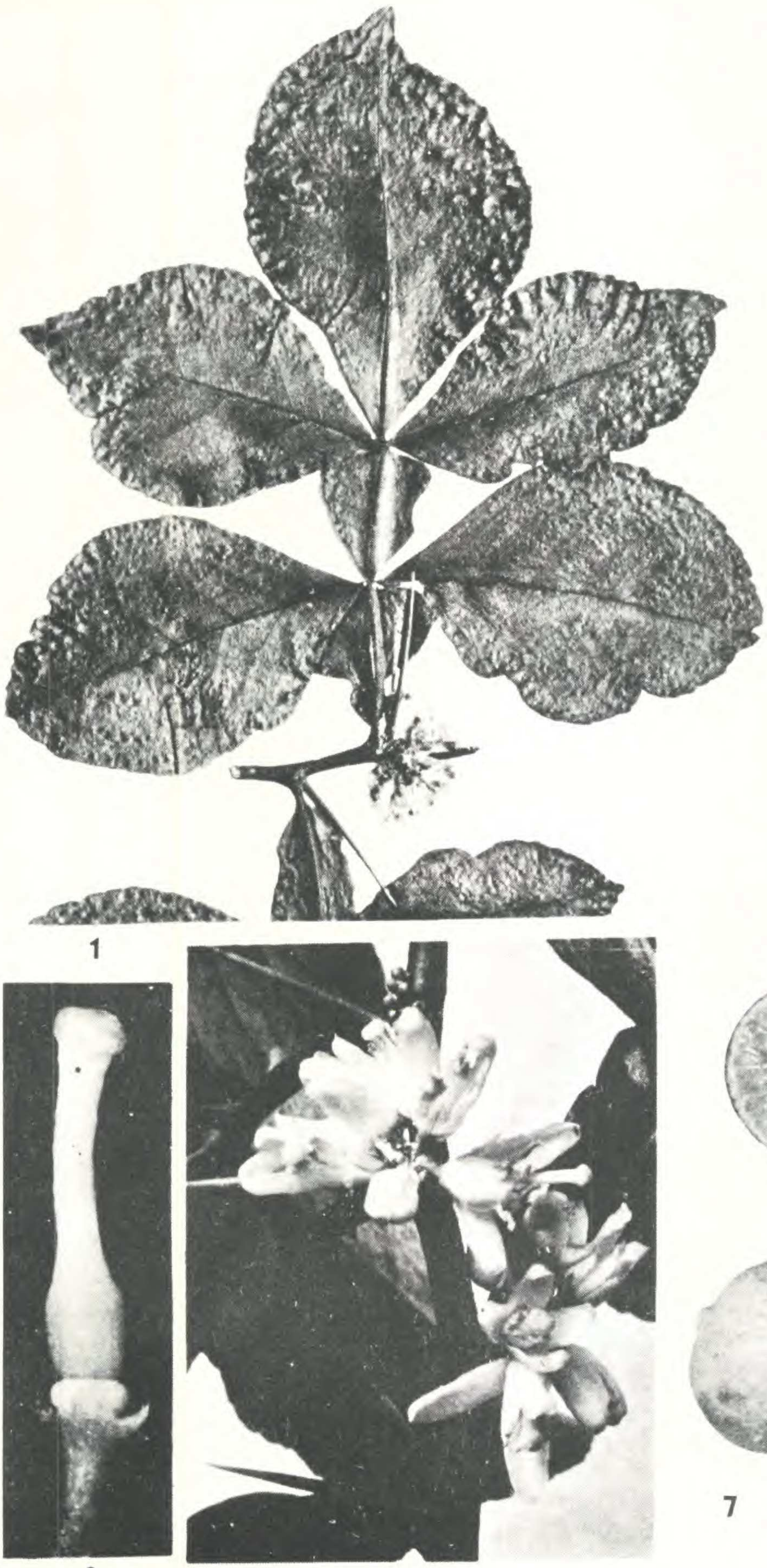
Atalantia racemosa var. *Henryi* Swingle. Figures 1–4 from type material.

Figure 1. Flowering branch. ½ nat. size.

Figure 2. Longitudinal section of fully mature flower. × 10.

Figure 3. Cross section of flower bud showing stigma with 4 stylar canals with 8 large oil-glands in pairs between the stylar canals; anthers show a single small oil-gland in connective, also 4-merous calyx and corolla. × 10.5.

Figure 4. Cross section of flower bud showing 4-locular ovary, stamens partially cohering, corolla and calyx lobes. × 10.



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CITROPSIS GILLETIANA Swingle & M. Kellerman

FULL-TONE — MERIDEN